limited number and the uncertainty of the correction for change of heat with phase render more certainty as to the fact desirable, we may (accepting them as probable) reason thus.

Previous observations both at Allegheny and Mount Whitney have shown that the solar rays are transmitted with greater and greater facility (except for cold bands) as the wave-length increases up to the point (near $\lambda = 3^{\mu}$) where they suddenly disappear altogether. This shows either that (1) the solar heat, which, according to the customary assumption, exists to an unlimited wave-length before absorption, has here been cut off by a suddenly absorbent action, like that of a cold band extending indefinitely below 3^{μ}, or (2) that, either through a precedent absorption of such rays in the sun's own atmosphere or their non-existence, no solar rays below 3^{μ} present themselves to our atmosphere for admission.

The first view is that which I have treated as most in accordance with received opinion. It is not, however, the only one, since the second is not to be absolutely rejected, considering our experimental ignorance of the laws of radiation from gaseous bodies for great wave-lengths. Of these two hypotheses we see that, according to the first, our atmosphere is quite opaque to all heat below 3^{μ}, and the writer's (unpublished) experiments show that heat above this point must come almost wholly from a source much above 100° C. In this view, then (unless we agree that the radiations from the lunar soil correspond to a source much above 100° C.), we conclude that sensibly none of them pass our atmosphere, but that what we receive is diffused and reflected heat coming within the range of the known solar energy spectrum, and transmitted with nearly the same facility as solar heat, or if with a little greater, because lowered in wave-length by selective reflection at the lunar surface, not by absorption and re-radiation from the lunar soil.

In the second view, for anything we have absolutely known to the contrary, our atmosphere may be permeable to radiations of any wave-length below 3^{μ}, and we could draw no certain inference, even if the lunar radiation were more distinctly different in transmissibility than it is.

As a matter of fact, with the actually limited difference in the character of its transmissibility, a difference which, as so far determined, is of the same order as that of the error of observation, we have no ground then from this present class of observation (*i.e.* Class 3) for any absolute conclusion one way or the other. But, we repeat, it seems to be a probable inference from our whole work that the earth's atmosphere is more diathermanous to heat of extremely low refrangibility than has heretofore been supposed.

(4) *Comparative Transmission of Glass for Lunar and Solar Heat.*—The evidence here, which at first seems to so directly support the view of a sensible radiation from the surface of the moon, proves, on examination, to be subject to other interpretation, for the observed effect is almost certainly due in part to a degradation of wave-length by selective reflection from the lunar soil.

We can draw no absolute conclusion, then, from this evidence, at first in appearance so promising, though we may say that it certainly indicates an increased probability for the view that radiations from the lunar soil may be transmissible by our atmosphere.

(5) *Observations during a Lunar Eclipse.*—If our own observations in this respect are imperfect, those of Lord Rosse, before cited, are, on the other hand, clear. They appear to bear but one interpretation—that all heat from the moon disappears immediately that it passes into the earth's shadow, and there is no evidence of any being retained, for any sensible time, more than if it were reflected.

It is so difficult to conceive that while the moon has been storing heat during many days of sunshine, it can part with it instantly, so that the temperature of the whole earthward surface of the planet disappears in an inappreciable interval, that most will see in this observation an argument against the existence of any such heat sensible to us at any time whatever.

(6) *Formation of a Lunar Heat Spectrum.*—The observations made here with the lunar heat spectrum are as yet incomplete. With improving experience and apparatus, we hope to make others which shall give information of a character no other means can furnish (see note, *infra*).

Conclusion.—While we have found abundant evidence of heat from the moon, every method we have tried, or that has been tried by others, for determining the character of this heat appears to us inconclusive; and, without questioning that the moon radiates heat earthward from its soil, we have not yet found any experimental means of discriminating with such certainty between this and reflected heat that it is not open to misinterpretation. Whether we do so or not in the future will probably depend on our ability to measure by some process which will inform us directly of the wave-lengths of the heat observed.

Note added February, 1885.—Since the above paragraph was written, we have succeeded in obtaining measures with rock-salt prisms and lenses in a lunar *heat spectrum*. These difficult measures must be repeated at many lunations before complete results can be obtained; but, considering their importance to the present subject, we think it best to state now in general terms, and with the reserve due to the necessity of future experiment, that they indicate two maxima in the heat curve—one corresponding within the limits of errors of observation to the solar curve maximum, the second indefinitely lower down in the spectrum, corresponding to a greater amount of heat at a lower temperature. Exactly what temperature this latter corresponds to we have no present means of knowing. We have succeeded, however, in forming a measurable heat-spectrum from the surface of a Leslie cube containing boiling water, and the maximum ordinate in the lunar heat curve appears to be below the maximum ordinate in the hot water curve. The inference from this is, of course, that the temperature of the lunar soil is, at any rate, below that of boiling water, and in an indefinite degree.

We cannot close this note without calling attention to the remarkable fact that we here seem to have radiations from the moon of lower wave-length than from the sun, which implies an apparent contradiction to the almost universally accepted belief that the sun's emanations, like those from any heated solid body, include all low wave-lengths representing temperatures inferior to those certainly emitted.

SYMBIOSIS BETWEEN FUNGI AND THE ROOTS OF FLOWERING PLANTS

A VERY remarkable phenomenon has for some time past attracted the attention of a few physiological botanists in France and Germany, and was the subject of an interesting discussion at the annual meeting of the Association of German Naturalists and Physicians at Strassburg in September last. This is no less than the discovery of the fact, which may now be considered fairly established, that a considerable number of phanerogams, especially forest trees, do not draw their nourishment directly from the soil, but through the medium of an investing layer of fungus-mycelium, to which B. Frank gives the name of Mycorhiza.

The observations which first called the attention of botanists to this interesting subject were those of F. Kamienski, on *Monotropa hypopitys*, published in the *Mém. de la Soc. Nationale des Sci. Nat. de Cherbourg*. He came to the conclusion that this plant is not, as is usually believed, a parasite, the most careful observation failing to detect any haustoria or other parasitic union with the root of any host. On the other hand, he found the root of the *Monotropa* to be completely covered by the mycelium of a fungus, which branches abundantly, and forms a pseudo-parenchymatous envelope, often two or three times the thickness of the epidermis, and especially well developed at the apex of the root. This fungus, the species of which M. Kamienski is unable to determine, is entirely superficial, not penetrating into the living cells, though occasionally forcing its way between those of the epidermis. He contends that the *Monotropa* derives its nourishment from the soil entirely through the medium of this fungus-mycelium; the only parts of the root which are in actual contact with the soil are composed of lifeless cells with no power of deriving nutriment from them. The connection of the fungus with the roots of the *Monotropa* is not one of parasitism, but of true symbiosis, each of the two organisms deriving support and nutriment from the other.

More recently similar observations on the mode of nutrition of trees belonging to the natural order Cupuliferæ have been made by Dr. B. Frank and confirmed by M. Woronin (both recorded in the *Berichte der Deutsch. Bot. Gesellschaft*). Dr. Frank finds the roots of our native oaks, beeches, hornbeams, chestnuts, and hazels, to be covered by a dense cortex of Mycorhiza, organically associated in growth with the root, and composed entirely of fungus-hyphæ, completely enveloping the whole of the root, even the growing point. The structure of this cortex is that of a sclerotium; it is composed of a dense mass of hyphæ,

varying in diameter from 2 to 10 micro-millimetres, usually in several layers, other endophyllic hyphæ penetrating from them into the root between the epidermal cells, these being still slenderer than those of the envelope. By this structure, the formation by the tree of root-hairs is entirely prevented, and it is through it alone that nutriment is absorbed out of the soil. It makes its appearance first on lateral roots of the young seedling, and is constantly being replaced by fresh formations on older roots. Dr. Frank found this Mycorhiza invariably present on every root examined of trees belonging to the Cupuliferæ, also occasionally on Salicaceæ and Coniferæ, but not on woody plants belonging to other natural orders, nor on any herbaceous plant. He also regards the phenomenon as an example of symbiosis, comparable in all essential points to that of lichens, the Mycorhiza corresponding to the fungal element, the tree itself to the algal gonidia. Dr. Woronin confirms these statements in relation to Coniferæ, Salicaceæ, and some other trees, and thinks it probable that the fungus is the mycelium of a *Boletus*. He regards it, however, as truly parasitic.

In the discussion which took place at Strassburg, Dr. Frank stated that the fact of this phenomenon having been observed especially in the Cupuliferæ, was probably due to the partiality of these trees for soil rich in humus. He had observed it also in the Abietineæ among Coniferæ, the Salicaceæ, the alder and birch among Betulaceæ, and in one instance each in the lime and blackthorn. He regards it as probably much more widely diffused than previous observations had suggested. Prof. de Bary, who accepts the explanation of the phenomenon as an example of symbiosis, pointed out that a similar relationship has long been known between Orchideæ and fungus hyphæ. Observations in the same direction have also been made by Riess and Janczewski. ALFRED W. BENNETT

NORWEGIAN TOADSTOOLS

AMONG the various interesting facts regarding the history of cryptogamic plants given in the new edition of Prof. Schübeler's great work on the flora of Norway, special interest attaches to the results of his experiments on *Amanita muscaria*, one of the commonest of the Norwegian toadstools. According to Dr. Schübeler, we have in this mushroom the source whence the ancient Scandinavians derived a preparation whose intoxicating and half poisonous properties induced symptoms of frenzied excitement, similar in all respects to those exhibited by the old northern warriors when taking part in a "Berserksgang," which appears to have been very similar to the so-called "running amok." Prof. Schübeler founds his opinion on the evidence given by the Russian writers, Kraschenninikow, Erman, and others, as to the effects produced on the Kamchatkans by a decoction of the Amanita, which they used as an intoxicating drink until they were brought into closer contact with the Russians, from whom they have acquired the practice of drinking spirits. In the present day this use of the Amanita seems to be limited to the nomadic Korjakes, with whom the neighbouring Kamchatkan tribes carry on a profitable trade, giving only one or two of these mushrooms in exchange for a reindeer. According to the testimony of the Kamchatkans, the first symptom noticed after drinking this so-called "Muchamór liqueur," one of whose ingredients is said to be the juice of *Epilobium angustifolium*, is a trembling in the limbs, followed after a time by great flushing of the face and general excitement and irritability, which in the case of many is accompanied with an abnormal increase of muscular force. Thus an instance is recorded in which a man while under the influence of this stimulant ran 15 versts carrying a sack of flour on his back weighing 120 lbs., which in his ordinary condition he could barely lift. On comparing the symptoms of intoxication by muchamor recorded among the nomads of North-Eastern Asia with the accounts given by Icelandic and other northern authorities of the condition of the Berserkers in their frenzy, Dr. Schübeler finds such complete harmony that there can be no doubt of the identity of the causes to which both may be referred. We know, moreover, that while the descriptions of the Berserkergang forcibly recall the frenzy induced by the use of hachish, or opium, neither of these stimulants could have been attainable in Iceland in ancient times, nor could brandy have been used by the northmen, since it was not introduced into Norway before 1531. The employment of mead or ale by the Bersekers is equally negatived by the symptoms recorded, which the writer seems to have traced beyond a doubt to their true source. It is worthy of notice that as early as the beginning of the eleventh century the law-givers of Iceland recognised the Berserkergang as a manifestation of frenzy, for which the actors were to be held accountable, while a law was introduced in 1123 which ordained that every man who took part in these outbreaks should be banished from the island for three years, and that a similar punishment should be awarded to all who were present and who did not help to bind the Berserkers and watch over them till their excitement had passed away.

SCIENTIFIC SERIALS

Bulletin de l'Académie royale de Belgique, October 10.—Note on the crepuscular lights observed towards the end of the year 1883, by M. Hirn. A new explanation is here suggested of this phenomenon, which is attributed to a highly electric condition of the upper atmospheric layers in combination with particles of matter floating round the globe, and possibly due to the Krakatoa eruption.—On the notion of force in modern science, by M. Hirn. In this essay force is removed from the almost mystic domain it has hitherto occupied, and brought within the sphere of actual experience. The question to be determined by science is, whether gravitation, electricity, heat, &c., are to be regarded as distinct entities, or different forms of the same element absolutely distinct from what we call ponderable matter. But owing to the prevailing confusion regarding the nature of force, it is better for the present to study its various dynamic manifestations, than to attempt to reduce them to one element.—Analysis of some rocks from the "rivers of stone" in the Falkland Islands, by A. Renard. Amongst these specimens is a square prism with regular polyhedric breakage showing a granitoid texture, and altogether typical of the eruptive masses frequently interspersed amongst Palæozoic formations like those of the Falkland Islands. This fragment must be classed in the group of diabase rocks, and may serve to throw some light on the origin of the remarkable "rivers of stone" described by Darwin and Wyville Thomson.—Note on the gemmation of the channels in the planet Mars, by F. Terby. It is suggested that this curious phenomenon may be the beginning of a periodical enlargement of the channels due to causes for which no analogy can be found on the terrestrial globe.—The ancient geography of Western Asia elucidated by means of the cuneiform inscriptions, by M. Delattre. By a careful study of the itineraries and warlike expeditions described in the Assyrian and Babylonian records the author endeavours to determine the position of numerous localities unknown to the Greek and Latin writers.—The origin of the Flemish people, by L. Vanderkinden. In reply to M. Wauters' recent memoir, the author shows conclusively that the Saxon and Frisian elements are largely represented in the present populations especially of Western Flanders.

Rivista Scientifico-Industriale, October 31.—Paramagnetism and diamagnetism, by Prof. Carlo Marangoni.—On the velocity of the rays polarised round the interior of a body endowed with rotatory power, by Prof. Augusto Righi.—Experiments on the heating of boilers with petroleum, by the editor.—On the native arsenic of the Valtellona district, by D. Bizzari and G. Campani.

Rendiconti del Reale Istituto Lombardo, November 12.—Critical and exegetic essays on the sources of Roman jurisprudence, by Prof. C. Ferrini.—Theoretical treatment of the question of the ventilation of rooms, showing that in all cases the ventilating apparatus should be placed above, by Prof. R. Ferrini.—On a question of priority of discovery in bacterio-therapeutics, by E. L. Maggi.—Analytical functions of a single variant with any number of periods, by E. F. Casorati.—Meteorological observations made at the Brera Observatory, Milan, during the months of August and September.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17.—"An Experimental Investigation into the Form of the Wave-Surface of Quartz," by James C. McConnel, B.A. Communicated by R. T. Glazebrook, M.A., F.R.S.

The paper contains an account of a number of measurements of